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## RESEARCH ARTICLE

# SYNTHESIS OF BISAZO REACTIVE DYES AND THEIR DYEING PERFORMANCE ON VARIOUS FIBRES

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4,4'-methylene bis anthranilic acid, characterisation, dyeing, fastness properties, colorimetric data.

### ABSTRACT

A series of bisazo reactive dyes has been synthesized by coupling of tetrazotized 4,4'-methylene bis anthranilic acid with various 2-((4-amino-3-methoxy phenyl) sulphonyl)ethyl hydrogen sulphato cyanurated coupling components such as H-acid, Gamma acid, J-acid, N-Methyl J-acid, N-Phenyl J-acid, Chicago acid, S-acid, K-acid, Bronner acid, Peri acid, Laurent acid, Koch acid, Naphthionic acid and Tobias acid. They were characterized by nitrogen elemental analysis, IR and <sup>1</sup>H NMR spectra. The dyeing performance of all these dyes on wool, silk and cotton fibres gave fair to good light fastness, good to excellent wash fastness and rubbing fastness. Spectral properties and colorimetric data ( $L^*$ ,  $a^*$ ,  $b^*$ ,  $c^*$ ,  $H^*$  and K/S) have also been investigated.

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## INTRODUCTION

Reactive dyes, the newest addition of existing dyes are the centre of attraction in dyestuff research (Shah K.M., 1994). These dyes are the only textile coloration products designed to furnish covalent bonds between dye and substrate during dyeing. Most of Procion dyes are water soluble, easily applied and because the reactive group may be attached to almost any coloured molecular system, can be used to produce both very bright and very dull shades of all colours. They are used for the dyeing and printing of cellulose and to a lesser extent polyamide fibres. In addition, investigations into the development of reactive dyes for polyester and polypropylene fibres have been demonstrated to the level of technical possibility but such dyes are not yet of commercial interest (Christie R. M., 2001; Rattee I.D., 1984).

Several new reactive systems have been introduced from time to time, which covers the subjects of innumerable patents and publications (JP, 1981; Seigel E., 1972; BP, 1967; EGP, 1968). Over the last decade a number of major changes have been taken place, primary aimed at minimizing the major weakness of reactive dyes for facilitating new application condition. In this period, monoazo reactive dyes (Patel et al, 2014; Patel et al, 2015; Patel et al, 2015) and bisazo reactive dyes (Patel et al, 1998; Patel et al, 2009; Patel et al, 2011)

have been established as a major group for fixation to cellulose.

## MATERIALS AND METHODS

The melting points of the compounds were determined using open capillary and are uncorrected. The purity of dyes was determined by thin-layer chromatography using silica gel-G coated Al plates. IR spectra were recorded on SHIMADZU, Model: FTIR 8400S using KBr pellets. <sup>1</sup>H NMR spectra were obtained on Bruker Avance-II 400 NMR spectrometer using D<sub>2</sub>O solvent and TMS as internal reference (chemical shifts in  $\delta$ , ppm). Colorimetric data ( $L^*$ ,  $a^*$ ,  $b^*$ ,  $c^*$ ,  $H^*$  and K/S) were recorded on Reflectance spectrophotometer Gregtag Macbeth Color-Eye 7000A.

### Synthesis of 4, 4'-methylene bis anthranilic acid (I) (Patel et al, 1996; Patel et al, 1999)

Anthranilic acid (13.7 g, 0.1mol) was dissolved in water (125 ml) and 36.5% hydrochloric acid (25 ml) at 50 °C and then treated with 3% aqueous formaldehyde solution (35ml). The temperature was maintained 60 °C and stirred for an hour and neutralized with 10% sodium hydroxide to give yellow precipitates of 4, 4'-methylene-bis anthranilic acid. It was filtered, washed with hot water, dried and recrystallized from ethanol. Yield: 84 %, m.p. 200-205 °C.

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**Tetrazotization of 4,4'-methylene bis anthranilic acid(II)**

4, 4'-Methylene-bis anthranilic acid (2.86 g, 0.01 mol) was suspended in H<sub>2</sub>O (30 ml). Conc. hydrochloric acid (10 ml) was added dropwise to this well stirred suspension. The mixture was gradually heated up to 70 °C, till clear solution was obtained. The solution was cooled to 0-5 °C in an ice bath. To this solution, NaNO<sub>2</sub> (1.38 g, 0.02mol) in water (5 ml) was added to the above solution at 0 °C temperature over a period of five minutes with continuous stirring. The stirring was continued for an hour, maintaining the same temperature, with positive test for nitrous acid on starch iodide paper. The excess of sulphamic acid was destroyed with required amount of sulphamic acid solution in water. The clear tetrazotized solution at 0-5 °C was obtained and used for subsequent coupling reaction.

**Synthesis of 2-(4-amino-3-methoxy phenyl sulphonyl)ethyl hydrogen sulphato cyanurated H-acid(III)****Cyanuration of H-acid**

Cyanuric chloride (3.69 g, 0.02mol) was stirred in acetone (50 ml) at a temperature below 5 °C for a period of an hour. A neutral solution of H-acid (6.38 g, 0.02mol) in aqueous sodium carbonate solution (10% w/v) was then added in small lots in about an hour. The pH was maintained neutral by simultaneous addition of sodium carbonate solution (1% w/v). The solution was used for subsequent coupling reaction.

**Condensation with 2-(4-amino-3-methoxy phenyl sulphonyl) ethyl hydrogn sulphate**

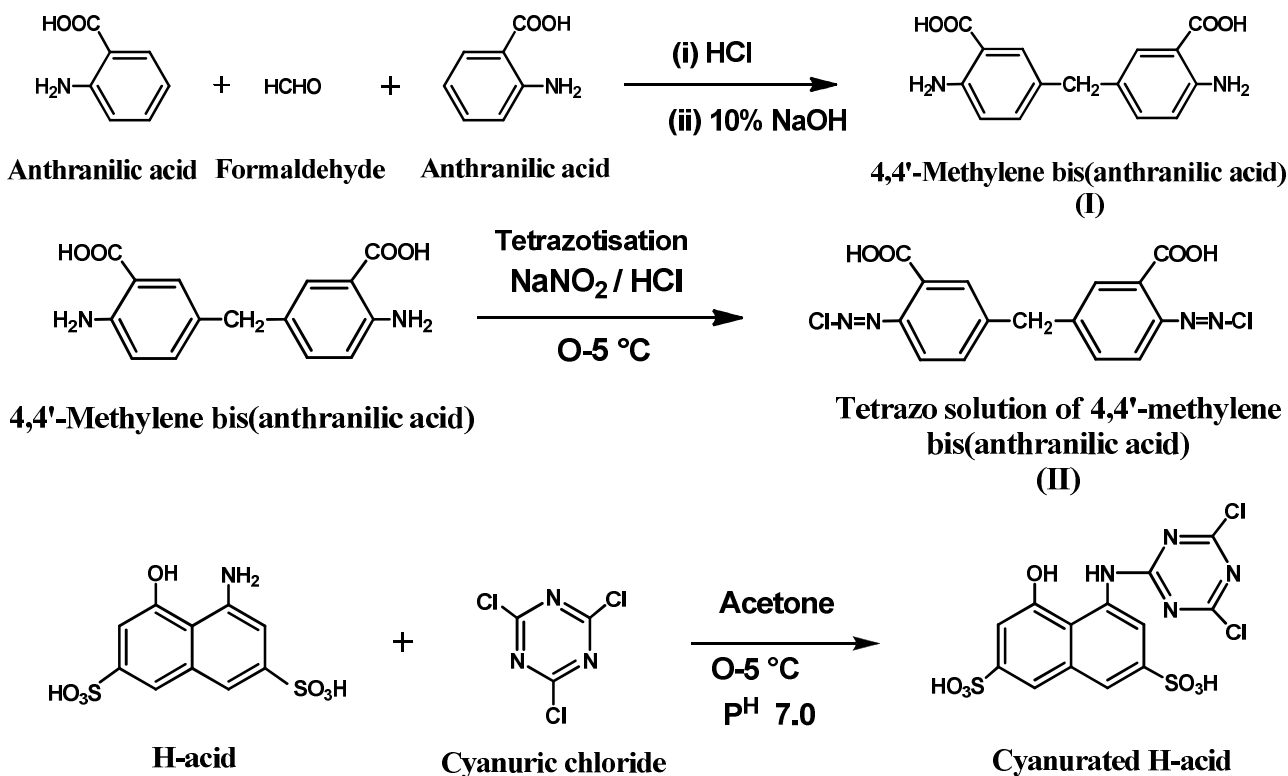
The temperature of ice-cooled well stirred solution of cyanurated H-acid was gradually raised to 45 °C. 2-(4-amino-

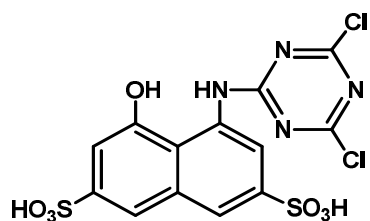
3-methoxy phenyl sulphonyl)ethyl hydrogen sulphate (6.22 g, 0.02 mol) was added slowly to the cyanurated H-acid solution at same temperature during a period of 30 minutes, maintaining the pH neutral by simultaneous addition of sodium carbonate solution (1% w/v). After the addition was completed, stirring was continued for further 3 hours. The 2-(4-amino-3-methoxy phenyl sulphonyl) ethyl hydrogen sulphato cyanurated H-acid solution thus obtained was subsequently used for further coupling reaction.

**Coupling of tetrazotized solution with 2-(4-amino-3-methoxy phenyl) sulphonyl) ethyl hydrogen sulphato cyanurated H-acid coupling component****Synthesis of dyes (D<sub>1</sub> to D<sub>14</sub>)**

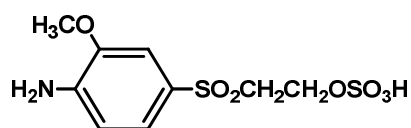
The above mentioned freshly prepared tetrazotized solution was added to an ice cooled and well stirred solution of 2-(4-amino-3-methoxy phenyl)sulphonyl) ethyl hydrogen sulphato cyanurated H-acid over a period of 10-15 minutes. The pH was maintained at 8.0 to 8.5 by simultaneous addition of sodium carbonate solution (10% w/v) and stirring was continued for 4 hours. Sodium chloride (15 g) was then added and the mixture was stirred for an hour. The solid dye separated out was filtered, washed with minimum amount of acetone and dried at room temperature.

Following the above procedure, other reactive dyes **D<sub>2</sub>** to **D<sub>14</sub>** were synthesized by using o-anisidino cyanurated coupling components such as Gamma acid, J-acid, N-Methyl J-acid, N-Phenyl J-acid, Chicago acid, S-acid, K-acid, Bronner acid, Peri acid, Laurent acid, Koch acid, Naphthionic acid and Tobias acid.

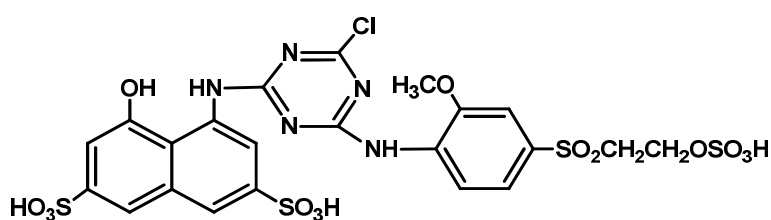
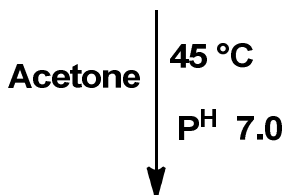
**Reaction Scheme**



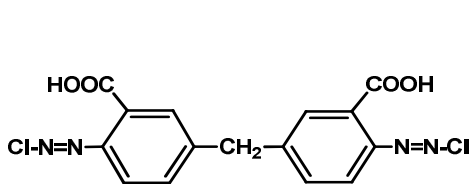
Cyanurated H-acid



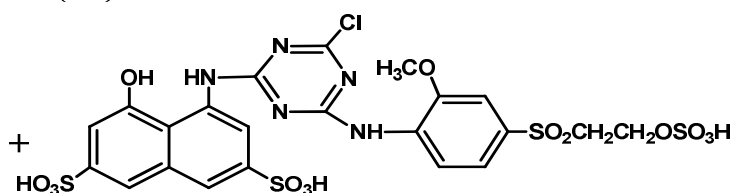
2-((4-Amino-3-methoxy phenyl)sulphonyl) ethyl hydrogen sulphate



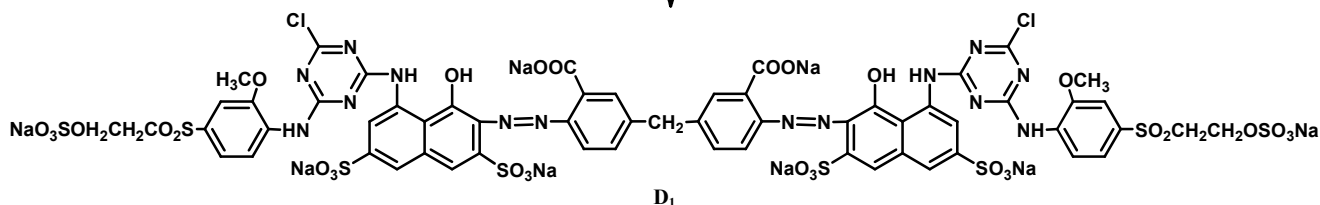
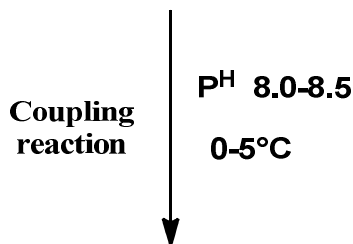
2-((4-Amino-3-methoxy phenyl)sulphonyl)ethyl hydrogen sulphato cyanurated H-acid (III)



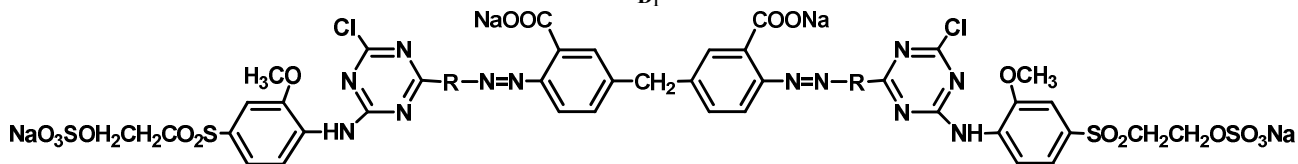
Tetrazo solution of 4,4'-methylene bis(anthranilic acid) (II)



2-((4-Amino-3-methoxy phenyl)sulphonyl)ethyl hydrogen sulphato cyanurated H-acid (III)



D<sub>1</sub>



(D<sub>1</sub>-D<sub>14</sub>)

Where, R= various coupling components to synthesise D<sub>1</sub> to D<sub>14</sub> (Table-1)

## RESULT AND DISCUSSION

### Characterisation

All the synthesised dyes have been characterised by Visible absorption spectra, some representative IR spectra and PMR spectra.

### Visible Absorption Spectra

The visible absorption spectra of all synthesised dyes have been recorded on in water and observed in the range of 550-383 nm. The colour observed for each dye is due to the oscillation of electrons and presence of substituents.

### IR Spectra

IR spectra of dye D<sub>1</sub> showed O-H stretching vibration of -OH group at 3440 cm<sup>-1</sup>, N-H stretching vibration of secondary amine at 3424 cm<sup>-1</sup>, C-H stretching vibration of -OCH<sub>3</sub> group at 2960 cm<sup>-1</sup>, C-H stretching vibration of -CH<sub>2</sub>- group at 2845 cm<sup>-1</sup>, C=O stretching vibration of -COOH group at 1707 cm<sup>-1</sup>, C=C stretching vibration of aromatic ring at 1608 cm<sup>-1</sup>, N=N stretching vibration of azo group at 1450 cm<sup>-1</sup>, C-N stretching vibration of tertiary amine group at 1533 cm<sup>-1</sup>, S=O stretching vibration of SO<sub>2</sub> group at 1336 and 1140cm<sup>-1</sup>, S=O stretching vibration of -SO<sub>3</sub>Na group at 1260,1160 and 1048 cm<sup>-1</sup>, C-Cl stretching vibration of chloro group at 725 cm<sup>-1</sup>.

IR spectra of dye D<sub>3</sub> showed O-H stretching vibration of -OH group at 3445 cm<sup>-1</sup>, N-H stretching vibration of secondary amine at 3390 cm<sup>-1</sup>, C-H stretching vibration of -OCH<sub>3</sub> group at 2960 cm<sup>-1</sup>, C-H stretching vibration of -CH<sub>2</sub>- group at 2842 cm<sup>-1</sup>, C=O stretching vibration of -COOH group at 1707 cm<sup>-1</sup>, C=C stretching vibration of aromatic ring at 1607 cm<sup>-1</sup>, N=N stretching vibration of azo group at 1449 cm<sup>-1</sup>, C-N stretching vibration of tertiary amine group at 1533 cm<sup>-1</sup>, S=O stretching vibration of SO<sub>2</sub> group at 1330 and 1137cm<sup>-1</sup>, S=O stretching vibration of -SO<sub>3</sub>Na group at 1260,1186 and 1052 cm<sup>-1</sup>, C-Cl stretching vibration of chloro group at 725 cm<sup>-1</sup>.

IR spectra of dye D<sub>4</sub> showed O-H stretching vibration of -OH group at 3438 cm<sup>-1</sup>, N-H stretching vibration of secondary amine at 3418 cm<sup>-1</sup>, C-H stretching vibration of -OCH<sub>3</sub> group at 2940 cm<sup>-1</sup>, C-H stretching vibration of -CH<sub>2</sub>- group at 2843 cm<sup>-1</sup>, C=O stretching vibration of -COOH group at 1708 cm<sup>-1</sup>,

C=C stretching vibration of aromatic ring at 1607 cm<sup>-1</sup>, N=N stretching vibration of azo group at 1449 cm<sup>-1</sup>, C-N stretching vibration of tertiary amine group at 1533 cm<sup>-1</sup>, S=O stretching vibration of SO<sub>2</sub> group at 1330 and 1136cm<sup>-1</sup>, S=O stretching vibration of -SO<sub>3</sub>Na group at 1257, 1160 and 1051 cm<sup>-1</sup>, C-Cl stretching vibration of chloro group at 710 cm<sup>-1</sup>.

### <sup>1</sup>HNMR Spectra

<sup>1</sup>HNMR Spectra of dye D<sub>2</sub> showed signals at 1.94 (s, 6H, -OCH<sub>3</sub>), 3.68-3.72 (t,4H,-CH<sub>2</sub>-protons), 3.91 (s,2H,-CH<sub>2</sub>-protons), 3.94 (s,2H,-NH-protons), 4.10-4.14 (t, 4H,-CH<sub>2</sub>-protons), 4.90 (s,2H,-OH proton), and 6.78-7.80 (m,22H, aromatic protons).

### Application

#### Dyeing of fibres

All the dyes were applied on silk, wool and cotton fibres by using the standard procedure (Shenai V.A., 1973).

#### Exhaustion and fixation study

The percentage exhaustion of 2% dyeing on silk fabric ranges from 68-75%, for wool ranges from 68-75 % and for cotton ranges from 68-75%. The percentage fixation of 2% dyeing on silk fabric ranges from 85-90 %, for wool ranges from 86-92% and for cotton ranges from 87-92% (Table-2).

#### Fastness properties

Fastness to light was assessed in accordance with BS: 1006-1978(Standard Test Method, 1994). The rubbing fastness test was carried out by using Crock meter (Atlas) in accordance with the AATCC-1961 (AATCC Test, 1961) and the wash fastness was carried out in accordance with IS:765-1979 (Indian Standard, 1979). All the dyes show generally fair to good light fastness properties. The washing and rubbing fastness properties ranges from very good to excellent fastness on silk, wool and cotton (Table-3).

#### Computer Colour Matching Data (CCM)

The colour on silk, wool and cotton fibres are expressed in terms of CIELab values and the coordinates measured are

**Table 1** Characterization of bisazo reactive dyes

Dye No.	Coupling component (R)	Molecular Formula	Mol. Weight g/mol	Yield (%)	M.P. °C	Nitrogen %		Rf Value
						Found	Req.	
D <sub>1</sub>	H-acid	C <sub>59</sub> H <sub>40</sub> N <sub>14</sub> S <sub>8</sub> O <sub>32</sub> Cl <sub>2</sub> Na <sub>8</sub>	1968	81	>300	9.88	9.96	0.56
D <sub>2</sub>	Gamma acid	C <sub>59</sub> H <sub>42</sub> N <sub>14</sub> S <sub>6</sub> O <sub>26</sub> Cl <sub>2</sub> Na <sub>6</sub>	1764	78	>300	11.02	11.11	0.60
D <sub>3</sub>	J-acid	C <sub>59</sub> H <sub>42</sub> N <sub>14</sub> S <sub>6</sub> O <sub>26</sub> Cl <sub>2</sub> Na <sub>6</sub>	1764	84	>300	11.04	11.11	0.58
D <sub>4</sub>	N-methyl J-acid	C <sub>61</sub> H <sub>46</sub> N <sub>14</sub> S <sub>6</sub> O <sub>26</sub> Cl <sub>2</sub> Na <sub>6</sub>	1732	76	>300	11.02	10.94	0.62
D <sub>5</sub>	N-phenyl J-acid	C <sub>71</sub> H <sub>50</sub> N <sub>14</sub> S <sub>6</sub> O <sub>26</sub> Cl <sub>2</sub> Na <sub>6</sub>	1916	86	>300	10.32	10.23	0.54
D <sub>6</sub>	Chicago acid	C <sub>59</sub> H <sub>40</sub> N <sub>14</sub> S <sub>8</sub> O <sub>32</sub> Cl <sub>2</sub> Na <sub>8</sub>	1968	78	>300	9.86	9.96	0.52
D <sub>7</sub>	S-acid	C <sub>59</sub> H <sub>42</sub> N <sub>14</sub> S <sub>6</sub> O <sub>26</sub> Cl <sub>2</sub> Na <sub>6</sub>	1764	82	>300	11.24	11.11	0.60
D <sub>8</sub>	K-acid	C <sub>59</sub> H <sub>40</sub> N <sub>14</sub> S <sub>8</sub> O <sub>32</sub> Cl <sub>2</sub> Na <sub>8</sub>	1968	77	>300	9.85	9.96	0.57
D <sub>9</sub>	Bronner acid	C <sub>59</sub> H <sub>42</sub> N <sub>14</sub> S <sub>6</sub> O <sub>24</sub> Cl <sub>2</sub> Na <sub>6</sub>	1732	81	>300	11.25	11.32	0.62
D <sub>10</sub>	Peri acid	C <sub>59</sub> H <sub>42</sub> N <sub>14</sub> S <sub>6</sub> O <sub>24</sub> Cl <sub>2</sub> Na <sub>6</sub>	1732	79	>300	11.20	11.32	0.58
D <sub>11</sub>	Laurent acid	C <sub>59</sub> H <sub>42</sub> N <sub>14</sub> S <sub>6</sub> O <sub>24</sub> Cl <sub>2</sub> Na <sub>6</sub>	1732	86	>300	11.38	11.32	0.56
D <sub>12</sub>	Koch acid	C <sub>59</sub> H <sub>38</sub> N <sub>14</sub> S <sub>10</sub> O <sub>36</sub> Cl <sub>2</sub> Na <sub>10</sub>	2140	79	>300	9.26	9.16	0.62
D <sub>13</sub>	Naphthionic acid	C <sub>59</sub> H <sub>42</sub> N <sub>14</sub> S <sub>6</sub> O <sub>24</sub> Cl <sub>2</sub> Na <sub>6</sub>	1732	82	>300	11.23	11.32	0.54
D <sub>14</sub>	Tobias acid	C <sub>59</sub> H <sub>44</sub> N <sub>14</sub> S <sub>4</sub> O <sub>18</sub> Cl <sub>2</sub> Na <sub>4</sub>	1528	80	>300	12.72	12.83	0.52

lightness (L\*), chroma (C\*), hue angle form 0° to 360°(H), a\* value represent the degree of redness (positive) and greenness (negative) and b\* represents the degree of yellowness (positive) and blueness (negative).

For silk fibre, the data summarized in Table-4 showed that dye D<sub>1</sub> is more darker and D<sub>13</sub> is more lighter. D<sub>4</sub> is more redder and D<sub>13</sub> is more greener, D<sub>12</sub> is more yellower and D<sub>1</sub> is more bluer, D<sub>1</sub> is more duller and D<sub>4</sub> is more brighter. D<sub>1</sub> has more

Table 2 Dyeing performance of Dyes D<sub>1</sub> to D<sub>14</sub>

Dye No.	Shade on silk fabric	Shade on wool fabric	Shade on cotton fabric	λmax	% Exhaustion			% Fixation		
					S	W	C	S	W	C
D <sub>1</sub>	Dark maroon	Magenta	Dark violet	550	74.75	74.5	74.7	90.30	90.60	91.03
D <sub>2</sub>	Maroon	Dark maroon	Dark maroon	534	74.05	73.95	74.1	89.80	90.60	91.76
D <sub>3</sub>	Red	Oranges red	Brownish maroon	501	73.85	73.65	73.95	88.01	91.64	90.60
D <sub>4</sub>	Red	Red	Reddish maroon	512	73.8	69.44	73.85	87.40	90.35	90.72
D <sub>5</sub>	Reddish brown	Rustic brown	Light brown	522	73.7	73.5	73.80	87.40	89.80	89.43
D <sub>6</sub>	Dark brown	Light brown	Brownish khakhi	379	70.95	70.85	71.05	89.49	88.92	88.67
D <sub>7</sub>	Yellowish brown	Orangey brown	Turmeric yellow	383	71.80	71.65	71.85	89.83	88.62	89.07
D <sub>8</sub>	Golden yellow	Yellowish brown	Yellow	361	71.45	71.2	68.35	87.47	87.78	87.05
D <sub>9</sub>	Dark yellow	Lemon yellow	Pale yellow	387	68.60	68.95	69.15	88.92	88.68	88.21
D <sub>10</sub>	Pinkish brown	Brick red	Light brown	385	70.4	70.25	70.45	85.23	86.83	88.71
D <sub>11</sub>	Pale yellow	Pale yellow	Yellow	388	68.7	68.50	71.0	88.79	87.59	89.44
D <sub>12</sub>	Golden yellow	Dark yellow	Dark yellow	386	69.20	68.90	70.15	88.15	87.80	88.38
D <sub>13</sub>	Light yellow	Light yellow	Pale yellow	391	68.45	68.35	69.85	89.85	87.88	87.32
D <sub>14</sub>	Light brown	Pale yellow	Yellow	386	69.25	68.95	69.60	90.25	88.46	88.36

S= silk, W= wool and C=cotton

Table 3 Fastness properties of Dyes D<sub>1</sub> to D<sub>14</sub>

Dye No.	Light fastness		Wash fastness			Rubbing fastness						
						Dry			Wet			
	S	W	C	S	W	C	S	W	C	S	W	C
D <sub>1</sub>	5-6	5-6	5	4-5	4-5	4	4	4	4-5	4	4-5	4-5
D <sub>2</sub>	5-6	5	5	4	4	3-4	5	5	4	4	3-4	4-5
D <sub>3</sub>	4-5	5	4-5	4-5	5	4	4	4	4	4-5	3-4	4
D <sub>4</sub>	4-5	5	4	4	4	4	4-5	4	3-4	3-4	4	3-4
D <sub>5</sub>	3-4	5	4	3-4	3	3	3	4-5	3-4	3	4	3-4
D <sub>6</sub>	4-5	4-5	4-5	4	4	3	4	4	4	3-4	4-5	3
D <sub>7</sub>	4-5	4-5	3-4	4-5	4	3-4	5	3-4	4	4	3	3
D <sub>8</sub>	4-5	5	4	4-5	4	4	4	4-5	3-4	3-4	4-5	3-4
D <sub>9</sub>	5-6	5	5	4-5	4	4-5	4	4	3-4	4	4	4
D <sub>10</sub>	4-5	4-5	5	4	4-5	4	4	5	4	4	4-5	4
D <sub>11</sub>	4	5	4-5	4	4-5	3-4	4	3-4	4	4	4	3-4
D <sub>12</sub>	5	4-5	5	5	4	3-4	4	4	3-4	3-4	3-4	4
D <sub>13</sub>	4-5	5	4-5	3-4	4	4	4	3-4	4	4	4-5	3-4
D <sub>14</sub>	4-5	5	5	4	4-5	4	4	4-5	4	4-5	4	4

S= silk, W= wool and C=cotton; Light fastness: 1-Poor, 2-Slight,3-Moderate, 4-Fair, 5-Good, 6-Very good,7-Excellent,8-Maximu; Wash and Rubbing fastness: 1-Poor, 2-Fair,3-Good, 4-Very good, 5-Excellent

K/S values given by the reflectance spectrophotometer were calculated at λmax and are directly correlated with the dye concentration on the substrate according to the Kubelka–Munk equation (Billmeyer et al, 1981; Volz H.G., 1995). The colorimetric data of silk, wool and cotton fibres for all dyes are summarised in Table-4. The K/S value graph of all the dyes is shown in Figure-1 and graph of b\* versus a\* for silk, wool and cotton fibres are shown in Figure-2, 3 and 4 respectively.

K/S value and D<sub>13</sub> has less K/S value.

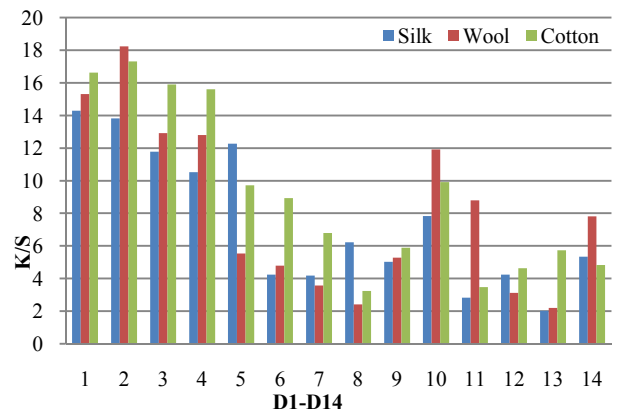


Figure 1 Graph of K/S value

For wool fibre, the data showed that dye D<sub>1</sub> is more darker and D<sub>13</sub> is more lighter. D<sub>3</sub> is more redder and D<sub>13</sub> is more greener, D<sub>12</sub> is more yellower and D<sub>1</sub> is less yellower, D<sub>6</sub> is more duller and D<sub>4</sub> is more brighter. D<sub>2</sub> has more K/S value and D<sub>13</sub> has less K/S value.

For cotton fibre, the data showed that dye D<sub>2</sub> is more darker and D<sub>8</sub> is more lighter. D<sub>2</sub> is more redder and D<sub>4</sub> is more greener, D<sub>12</sub> is more yellower and D<sub>1</sub> is more bluer, D<sub>2</sub> is more duller and D<sub>12</sub> is more brighter. D<sub>2</sub> has more K/S value and D<sub>8</sub>

Table 4 Color measurement (CIELab) data of Dyes D<sub>1</sub> to D<sub>14</sub>

Dye No.	L*			a*			b*			C*			H*			K/S		
	S	W	C	S	W	C	S	W	C	S	W	C	S	W	C	W	C	
D <sub>1</sub>	-18.04	0.15	-0.16	-29.91	-0.02	-5.44	0.65	-0.3	-8.22	-29.59	0.1	0.45	-4.39	-0.28	-9.85	14.28	15.31	16.63
D <sub>2</sub>	-0.55	-2.25	-9.85	-18.29	2.78	-11.27	5.45	13.5	8.64	-18.45	1.69	-12.94	4.91	13.68	5.84	13.81	18.23	17.32
D <sub>3</sub>	5.99	12.55	-5.13	2	25.13	4.35	29.38	43.98	19.36	8.77	35.92	5.09	28.11	35.72	19.18	11.78	12.91	15.89
D <sub>4</sub>	4.92	10.84	-3.29	4.66	21.77	6.51	34.92	36.61	15.43	13.99	28.84	5.79	32.33	31.35	15.71	10.52	12.8	15.61
D <sub>5</sub>	16.04	17.95	1.46	-16.21	8.4	-1.8	22.52	34.76	18.05	-10.21	17.22	-1	25.8	31.34	18.11	12.27	5.53	9.72
D <sub>6</sub>	12.25	20.8	33.05	-29.1	-7.38	-11.88	23.58	22.86	41.71	-18.15	-2.3	12.95	32.76	23.91	41.39	4.23	4.79	8.93
D <sub>7</sub>	25.48	35	31.16	-25.86	-3.05	-0.15	44.81	43.59	59.2	2.51	17.65	33.16	51.68	39.97	49.05	4.19	3.57	6.79
D <sub>8</sub>	30.47	36.95	52.26	-29.67	-7.44	-15.31	43.1	44.32	35.99	-0.28	16.68	6.68	52.32	41.72	38.54	6.23	2.41	3.23
D <sub>9</sub>	34.58	51.56	45.31	-36.4	-18.07	-11.25	44.6	43.04	50.34	-0.08	13.41	21.52	57.57	44.71	46.88	5.02	5.27	5.89
D <sub>10</sub>	20.25	33.48	31.87	-19.01	3.4	-6.6	25.42	35.89	23.03	-10.42	14.61	-1.66	29.98	32.95	23.9	7.83	11.92	9.92
D <sub>11</sub>	39.76	46.02	49.18	-36.82	-15.82	-13.87	47.92	44.98	48.88	3.18	15.53	19.63	60.34	45.09	46.86	2.82	8.79	3.47
D <sub>12</sub>	36.79	45.22	41.37	-38.92	-17.26	-5.89	54.69	54.52	62.31	9.82	24.92	34.38	66.4	51.47	52.3	4.23	3.12	4.64
D <sub>13</sub>	43.47	52.97	47.44	-42.57	-20.64	-10.09	38.41	39.11	54.07	-6.44	9.46	25.4	56.97	43.2	48.79	2.03	2.19	5.73
D <sub>14</sub>	39.58	48.33	49.66	-36.61	-16.33	-11.12	37.02	43.03	49.8	-7.63	13.53	21.01	51.5	43.99	46.5	5.34	7.81	4.82



has less K/S value.

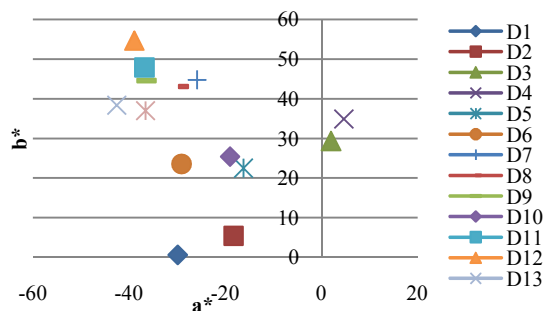


Figure 2 Graph of  $b^*$  vs  $a^*$  for silk fibre

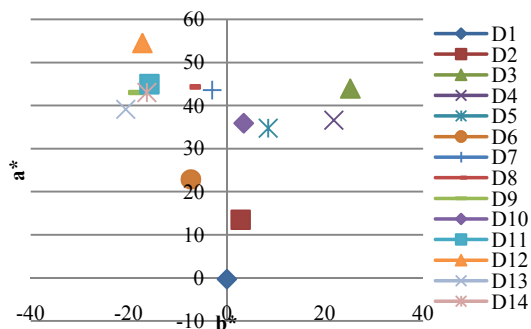


Figure 3 Graph of  $b^*$  vs  $a^*$  for wool fibre

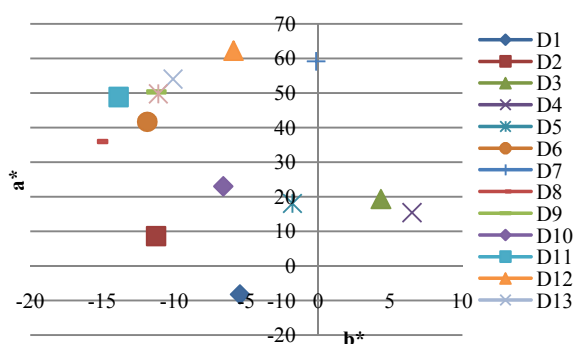


Figure 4 Graph of  $b^*$  vs  $a^*$  for cotton fibre

## CONCLUSION

4,4'-Methylene bis anthranilic acid was tetrazotised and coupling with various 2-((4-amino-3-methoxy phenyl) sulphonyl) ethyl hydrogen sulphato cyanurated coupling components gave corresponding bisazo reactive dyes ( $D_1$  to  $D_{14}$ ). These dyes gave violet to yellow shade on silk, wool and cotton fibres and showed fair to good light fastness, good to excellent fastness to washing and rubbing fastness. Exhaustion and fixation of these dyes are very good in order. The presence of triazine group of dye molecule improves the exhaustion, fixation and fastness properties.  $D_1$  has highest K/S value for silk fibre and  $D_2$  has highest K/S value for wool and cotton fibre. Thus,  $D_1$  has more dye concentration on silk fabric and  $D_2$  has more dye concentration on wool and silk fibre.

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